Australasian Plant Conservation

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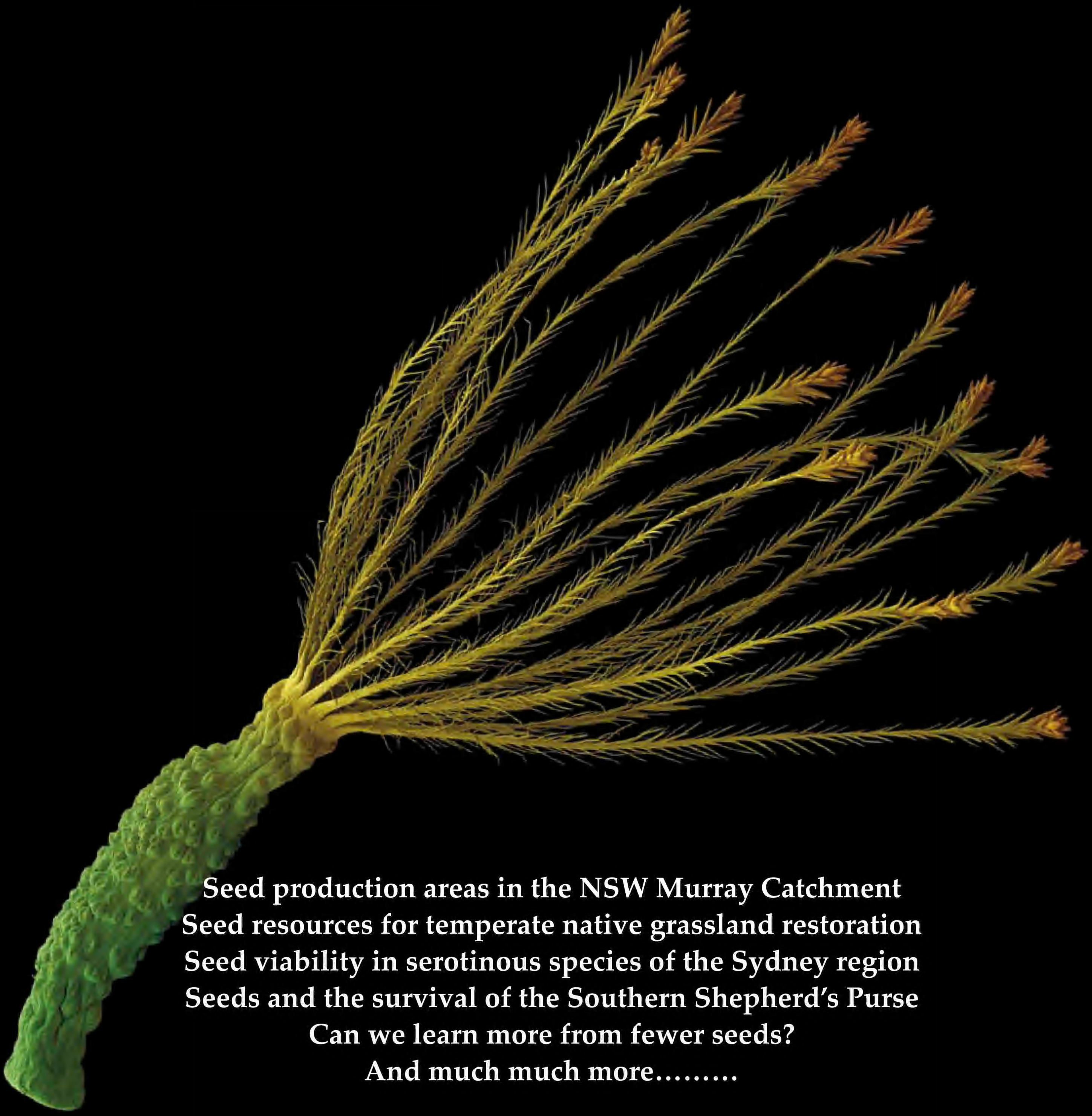

Seed production areas in the NSW Murray Catchment
Seed resources for temperate native grassland restoration
Seed viability in serotinous species of the Sydney region
Seeds and the survival of the Southern Shepherd's Purse
Can we learn more from fewer seeds?
And much much more.........

SPECIAL THEME: SEED RESOURCES

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ANPC Inc. Mission Statement

"To promote and improve plant conservation"

Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. **The deadline for the September-November 2006 issue is Friday 1st September.** The September-November issue will be on the special theme of 'Conserving Mutualisms', however general articles are also very welcome. Please contact Tom May if you are intending to submit an article: tom.may@rbg.vic.giv.au.

Authors are encouraged to submit images with articles or information. Please submit images as clear prints, slides, drawings, or in electronic format. Electronic images need to be at least 300 dpi resolution, submitted in at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors are at: http://www.anpc.asn.au/anpc/pdffiles/APCGuideContrib.pdf.

Please send typed or handwritten articles, no more than two A4 pages (or 1100 words), by fax, mail, email, or on disk. If sending by email, please send as a MS Word (2000 compatible) or rich text format attachment to: tom.may@rbg.vic.giv.au.

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Front cover: *Leucochrysum molle* from *Seeds: Time Capsules of Life* by Rob Kesseler and Wolfgang Stuppy, Papadakis Publisher, London, 2006. Used with permission. See review on page 19.
Cover design: Siobhan Duffy.
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President's Report

Judy West

Centre for Plant Biodiversity Research, CSIRO Plant Industry

Increased conservation activities involving seeds of native plant species in recent years and the realisation that our knowledge of seed biology is lacking in some areas has stimulated a range of research projects studying seeds. Improved knowledge of the biology, ecology and genetics of key species has in turn provided feedback to on-ground practitioners and enhanced the sustainable nature of the various initiatives. Having scientists and landholders, land managers and conservationists working together ultimately results in more diverse conservation outcomes.

Conservation of Seed Resources provides the theme of this issue of APC. This provides the opportunity to bring to attention the diversity of enterprises undertaken in recent times, including the partnerships established over the past few years between most Australian States and Territories and the Millennium Seed Bank (MSB) of the Royal Botanic Gardens Kew. Some Australian seed banks have existed for some time, others are newly established with support from MSB. There is also much activity at a local level in terms of production and collection of seeds.

It is widely recognised that the single-seedlot-per-species approach of the MSB Australian program does not reflect the sum total of needs for conservation collections. More genetically representative collections for each species will be developed over time, as has been done already to some extent by Australian seed banks. The MSB funding has been a great stimulus to seed banking in Australia, and will facilitate the building of core collections, capabilities and further seed research programs. A report is included here from the newly appointed Co-ordinator for Australian MSB partnerships, Tom North.

Other articles illustrate some of the advances that have been made in areas such as seed provenance selection, seed handling and storage, seed viability, seed orchards and applications. An innovative method of laying out seed orchards in the Murray Catchment of NSW using PVC tape is described. It is encouraging to see research emerging from seed bank initiatives, and this issue contains reports of studies into strategies for collecting seeds from species which retain seed on the plant, and into experimental design using seeds where a number of different treatments are being investigated.

Innovative research is also underway to enhance our knowledge of seed biology, ecology and genetics of undesirable species, since improving our abilities of actively managing environmental weeds assists conservation efforts. For instance, understanding the movement and gene flow of willow seed of different origins, from different species in different catchments of the Upper Murray system will contribute to more effective management options for this group of plants that choke our vital river systems. I anticipate being able to report on those studies in a future issue.

On a more general note, ANPC's recent activities have concentrated on south-eastern Australia and particularly in NSW for several reasons. The Committee is attempting to broaden the network's impact to other regions and would welcome suggestions from others. With our Secretary Helena Mills recently moving to WA this may provide a greater critical mass and opportunity to stimulate other members into action in that state.

Australasian Plant Conservation

CALL FOR CONTRIBUTIONS

The next issue of *Australasian Plant Conservation* will be on the theme of '**Conserving Mutualisms**'. Contributions are requested on any aspect of the conservation of mutualisms (partnerships), such as between orchids and mycorrhizal fungi, truffle-like fungi and mycophagous mammals, or plants and their pollinators or seed dispersers. In many such partnerships, each organism is dependent on the other, and the challenge is to conserve both partners for mutual benefit.

Most issues of APC now have a special theme. However, articles about any aspect of plant conservation are always welcome.

Suggestions for future special themes are also welcome.

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Seed resources for temperate native grassland restoration

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Remnant Australian temperate grasslands typically occur as small, fragmented communities of varying species diversity. Many of these species are vulnerable to local extinction from human activities such as agriculture and urban development, or processes such as exotic plant invasion and changed environmental conditions. If these species, communities, and their regional diversity, are to be retained into the future, existing remnants must be conserved, managed and enhanced. This can be achieved through the reconstruction of functioning communities at a landscape scale.

Community reconstruction: the need for seed

Intact temperate native grasslands support high densities and diversity of plants. Tussock grasses are the dominant life form, with the gaps between the tussocks occupied by a suite of annual and perennial forbs. Reconstruction of such communities requires large amounts of seed from each of the component species. Mortlock (2000) reported that the market for seed of locally indigenous species was relatively small and unreliable, and that there was little commercial interest in collection outside those mainstream species used by wholesale nurseries or land managers. Therefore, the quantity and variety of seed that is immediately available is limited, even for small-scale or experimental projects.

Seed quality

Most temperate grassland species have rarely, if ever, been harvested commercially. For collectors working with an unfamiliar flora, recognising mature inflorescences and filled seed is often a challenge and the collection of empty and immature seeds reduces the quality of their harvest.

Measurement of the quality of seed has multiple components including:

- the pure seed proportion;
- the presence of other species' seed;
- the proportion of other materials (plant parts other than seed, soil, fungal bodies, insects); and
- germination capacity.

Undertaking analyses of seed for the numerous species needed for the restoration of temperate grasslands is time consuming and expensive. However, ignoring seed quality invites failure in otherwise well-managed projects, through poor establishment of sown species and the inadvertent inclusion of weeds in sown mixes. Careful control of quality when sourcing seed, either from field collections or cultivated crops, simplifies seed analysis.

Field collection

A comprehensive collection of local grassland species will usually require a combination of hand and mechanical harvesting. Mechanical harvesters deliver seed volumes on the scale of wool bales rather than paper bags, dramatically reducing the time and cost of the initial harvest. While this method has the potential to collect a diverse suite of species, it will exclude genotypes not carrying seed at the time, or where seed is held below the height of the harvester. Also, there is a high risk of including invasive weeds. Once weed seeds contaminate the harvest, they are extremely difficult and costly to remove (Fig 1). Ideally, opportunities for efficient mechanical field harvesting will increase as the areas of well-managed remnant and reconstructed grasslands expand.

Hand harvesting selectively targets individual species dispersed within a remnant. However, it is time consuming and seldom completely eliminates weed contamination (e.g. the fertile florets of weedy grasses such as *Aira* species often lodge in the mature inflorescences of other grasses and forbs).

Seed production

Field crops

The cultivation of plants for the production of seed using established agronomic or horticultural seed production

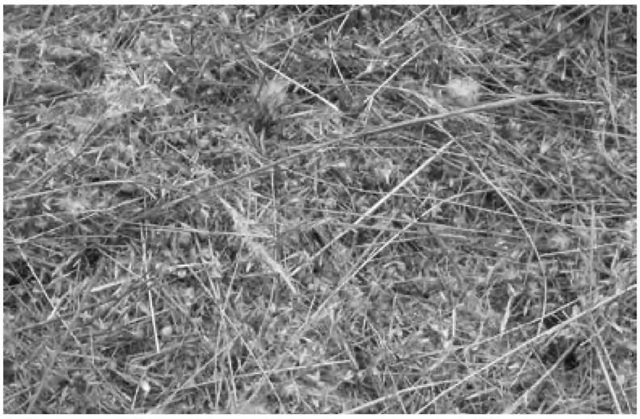
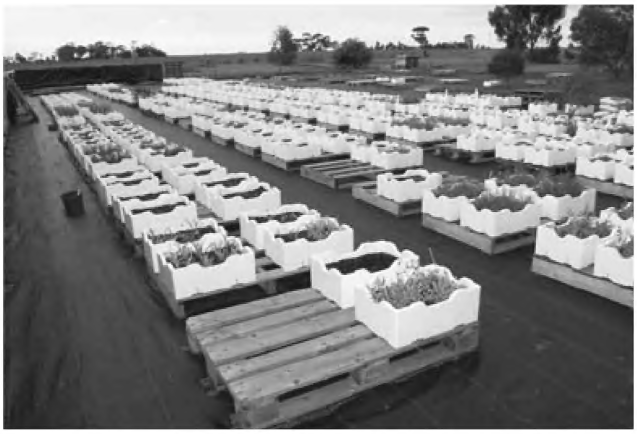


*Figure 1. The mechanical harvesting of grassland remnants can collect large quantities of locally-indigenous species but risks serious weed contamination. This seed lot is heavily contaminated with Quaking Grass (*Briza *spp.). Photo: John Delpratt*



Left: Figure 2. Commercial field production of native grass seed. Photo: John Delpratt.
Right: Figure 3. One of several containerised seed production areas developed by the Grassy Groundcover Research Project to supplement field collections of indigenous forbs. Photo: Paul Gibson Roy

techniques reduces collection pressure on local populations and allows for greater control over the quality of harvested seed. Cole and Johnston (2006) have recently published a comprehensive review of issues related to the cultivation of Australian native grass cultivars for seed production. Although local revegetation will usually specify the use of regional seed rather than commercial varieties, most of the technical challenges and emerging solutions for the production of high quality seed are identical (Fig 2). Because of the quantities of grass seed required to sow substantial areas of grassland, cultivation for seed production will require well-managed field crops that can deliver large quantities of clean seed of known identity.

Container crops

Much of the diversity in a temperate grassland is contributed by its many and varied non-grass species. Many of these forbs propagate easily from seed. They thrive in commercial nursery mixes, reproduce quickly and produce relatively large quantities of seed from a small area (Delpratt 1996). They are well suited to intensive, above-ground seed production systems that simplify harvest and produce reliable quantities of high quality seed.

For example, container crops are being used to produce seed for over 150 forb species for the Grassy Groundcover Research Project (GGRP), a large scale experimental grassland reconstruction program in south-western Victoria (GGRP 2006). Plants are grown in a pine bark medium in irrigated containers, as a one- or two-year crop. GGRP has established five regional seed production areas to supplement field collections for thirteen restoration sites (Fig. 3).

Genetics

Regardless of the seed production system, the harvested seed for each species should retain the genetic structure of the source population. Production plants must be grown from seed that captures the genetic diversity of locally occurring populations (FloraBank 2000). To reduce the impact of inbreeding during cultivation, seed production crops should be replaced routinely with new plants grown from wild-harvested seeds, rather than from seeds produced in cultivation. To avoid hybridisation, related crops should be isolated from each other in space or time. We replace container crops after one, or at most two, harvest seasons. Large field crops of perennial grasses may be retained for a number of seasons, provided weed control is adequate. Research is needed to compare the genetic diversity in seed lots harvested from cultivated crops after one or more generations, with that of the initial wild-harvested seed. Given the numbers of species involved, and the expense of detailed genetic investigations, the precautions outlined above should be followed until more information is available.

Conclusion

The reliable supply of seed of known quality is a fundamental resource for effective plant community restoration. Harvesting from local stands of remnant or reconstructed grasslands with low levels of weed contamination is relatively inexpensive. However, it can be time consuming and expensive to analyse the content of the harvest. Well-managed field and containerised crops, grown from wild seed, offer a reliable supply of seed for most of the species required for grassland restoration and reconstruction. Further development of these systems will need relatively stable demand for seed at a regional level, and ongoing development of the agronomy, harvesting, processing and storage requirements of numerous species new to cultivation.

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Seed production areas in the NSW Murray Catchment

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The problem

The NSW Murray Catchment covers an area of 35,170 sq km from the Great Divide in the east to the junction of the Murray and Murrumbidgee rivers west of Swan Hill. It has been recognised in the Murray Catchment Action Plan that there is a need to maintain and enhance the biodiversity of the region through landscape restoration. The best way to achieve this is through the use of local native species to restore recognised vegetation communities. Low natural stocks of native seed sources hamper this approach.

Native seed harvest in the NSW Murray catchment has always been a difficult proposition due to the lack of existing remnant vegetation. This has been especially so in the east where vegetation clearance has been extensive on rich agricultural land. For example, in Greater Hume and Corowa shires remnant vegetation cover is less than 5% of the total area. Large distances need to be travelled to collect seed, which adds considerably to the expense of the exercise.

With a succession of below average rainfall years over the preceding six years, the ability to meet the demand for seed for revegetation works has far outweighed supply. This situation highlights the unpredictability of seed supply. In addition, it is apparent too much reliance has been placed on roadside remnants as our principal source of seed. Cunningham (2000) confirmed that habitat fragmentation can lead to decline in pollination and subsequent fruit and seed set in wild plant populations. This is especially so in linear reserves, such as roadsides, where habitat fragmentation and small population size lead to inbreeding. An inbreeding depression occurs when there is no gene flow between fragmented populations, reducing the gene pool (Dudash and Fenster 2000). Inbreeding may affect a wide range of traits such as seed, seedling and adult size, fecundity, germination and survival and growth/reproduction of the offspring (Charlesworth and Charlesworth 1987). Inbreeding depression has been shown to have major consequences for plant conservation in general and would be expected to affect the health of future revegetation works in the catchment.

The solution

Over the last six years Seed Production Areas (SPAs) have been established in the NSW Murray catchment in order to:

- provide a viable and cost effective source of indigenous seeds from understorey species for revegetation works; and
- overcome the problem of population fragmentation by artificially creating a larger gene pool. This is achieved by combining plants from a number of sites within a provenance (a local area) on the one site, so that we are effectively increasing the gene pool of the offspring produced.

Through various funding initiatives by Greening Australia, the NSW Environmental Trust and now by the Murray Catchment Management Authority (CMA), the total area currently set aside for indigenous seed production is 160 hectares. The Murray CMA Seedbank has been established with an ongoing investment in the establishment of SPAs and with the aim of SPAs providing 80% of seed supply for the catchment by 2015. It is predicted that by that time seed demand will be approximately two tonnes per year delivered by direct seeding and seedlings.

The initial SPA plantings had the aim of establishing colonising species, for example, *Acacia* and *Dodonaea*, suitable for use in direct seeding. Sites were selected on interest shown by landholders in taking part in the program. Landholders receive payment for seed harvested from SPAs on their land.

The second phase of SPA establishment is looking to supplement existing plantings with locally rare species and add another suite from the forbs and grasses. Any new sites are targeted to areas where revegetation demand is highest and seed supply sources are low.

Through the adoption of innovative techniques we were able to extend the amount of area under seed production. The introduction of PVA seed tape resulted in the reduction of SPA establishment costs. Seeds are attached to the sticky surface of PVA tape, which is then laid directly on the ground, rather than having to raise and plant individual seedlings. Use of PVA tape also assists in laying out evenly-spaced lines of seedlings. Using existing fencing also reduced the overall project costs and allowed for a greater area of establishment.

The project has been faithful to the guidelines for establishing seed production areas as set out by Mortlock (1999).

Results

Seed production areas have proved their worth, with production increasing significantly across the last three years:

- 2003 - 14 kg harvested
- 2004 - 123 kg harvested
- 2005 - 221 kg harvested

Anecdotal evidence suggests SPAs are more likely to set viable quantities of seed in comparison to remnant vegetation which has been affected by drought and/or frost. This could be due in part to the age of the plantings.

Prices paid for seed are on a sliding scale depending on how much collection and processing the landholder does compared to how much the Murray CMA Seedbank undertakes. As native seed harvest coincides with cropping time, around December, most landholders rely on Murray CMA - Seedbank to collect and process the seed.

Average prices paid per kilogram have been:

- 2003 - 14 kg @ $650 = $21/kg,
- 2004 - 123 kg @ $2000 = $62/kg,
- 2005 - 221 kg @ $8417 = $27/kg.

Obstacles to overcome

This program has required initiative and persistence in ensuring delivery. Four of the main issues have been:

- **Management:** commitment from landholders, in relation to establishment, weed control and stock control;
- **SPA maintenance on a year to year basis:** including pruning and slashing for access;
- **Genetic diversity:** collection from enough sites within a provenance and identification of genetic differences within species (eg. *Acacia acinacea*); and
- **Environmental:** below average rainfall from 2001 to 2006 and late frosts affecting fruit set.

Good site selection has helped in overcoming some of the issues of management, maintenance and environmental conditions. It was inevitable that some areas were abandoned, mostly due to a combination of problems rather than a single issue. The benefit of good planning was evident once seed production started, and both the quantity and quality of seed were enhanced through good cultural practices.

Involvement by the community over the past six years has been widespread and diverse. Landholders and volunteers have given many hours of in-kind support to the project. Practically, seed production areas will require ongoing maintenance and revitalisation to ensure the productive viability of the plants within the area. As landholders are supported through incentive schemes to undertake revegetation projects, then the commercial brokerage of local indigenous seed for these projects becomes a viable possibility.

The project will take another three to four years before a full assessment of its worth can be made. By then, most plants within the majority of SPAs will have reached maturity.

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NEWS! The ANPC now has its own domain name

The ANPC now has its own registered domain name, which means our email and website addresses have changed.

Don't panic - the old ones still work.

The reason for this change is to clearly identify the ANPC as a separate and independent organisation. Our previous email and website details could infer we are part of the Commonwealth Department of Environment and Heritage. While we are very grateful for the Department's continuing support of the ANPC (providing office space and computer support), we are a separate not-for-profit organisation, independent of government.

So test these:

Website: http://www.anpc.asn.au

ANPC staff email: anpc@anpc.asn.au

Please let us know if you have any problems with these new addresses.

Seed management for large-scale land restoration

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Introduction

Alcoa World Alumina Australia (Alcoa) mines bauxite in the northern jarrah (*Eucalyptus marginata*) forest of Western Australia, 120 km south-east of Perth. Approximately 550 ha are mined and rehabilitated each year at two operating mines, Huntly and Willowdale. Alcoa's restoration objective is to restore a functional jarrah forest ecosystem that fulfils all of the pre-mining land uses of the jarrah forest. An important land use is conservation and to this end Alcoa endeavours to return a high diversity of jarrah forest plant species into restored areas. Plant species return from three main sources: from the natural seedbank in the returned topsoil, from applied seed and from greenstock planting. Alcoa aims to maximise the return of species from all of these sources.

Alcoa's Marrinup nursery is 10 km from the Huntly mine and has supplied plants and seed for rehabilitation since 1980. Broadcast seedmixes are comprised of 70–100 jarrah forest understorey and tree species, locally collected from pre-determined provenance zones. Marrinup Nursery also provides 100,000 to 200,000 greenstock plants each year of 20 species that do not establish well from applied seed or returned topsoil. These are produced by tissue culture or cuttings in the laboratories at Marrinup Nursery for direct planting into the field.

Orchards for seed collection

Although 70% of the plant species recorded in rehabilitated sites originate from the topsoil (Koch and Ward 1994), applied seed provides a consistent and important method of returning species that are not present in the soil seedbank. Over 2,700 kilograms of seed of 200 jarrah forest species were collected by seed merchants in the 2005-06 season for broadcast seedmixes, for research and to initiate tissue cultures at Marrinup Nursery.

The quantity and quality of seed available for picking can vary greatly depending on the species and environmental conditions during seed set. This can lead to an inconsistent supply of seed of some species that are jarrah forest key components. To overcome this, Marrinup Nursery created an on-site seed orchard in 2001 designed specifically to supplement seed supply for species such as *Bossiaea ornata, B. pulchella, Chorizema dicksonii, C. ilicifolium, Daviesia physodes, D. cordata, Dryandra lindleyana, Labichea punctata, Gompholobium marginatum, Hovea trisperma* and some *Acacia* species (Fig. 1). Constant management of the seed orchard is crucial to its success. Weeding, pest control, pruning and fertilising is done regularly, and any dead plants are replaced by new seedlings to ensure continual seed production for the future.

In 2005 the seed orchard provided Alcoa with over 75% of the *C. dicksonii* seed required for seedmixes. For four other species, the orchard was the only provider of seed. With each successive year supplying more seed than the last, the Marrinup seed orchard has become an integral component of Alcoa's rehabilitation program. Alcoa is now establishing in-ground, fenced seed orchards in previously mined areas to further improve reliability of seed supply.

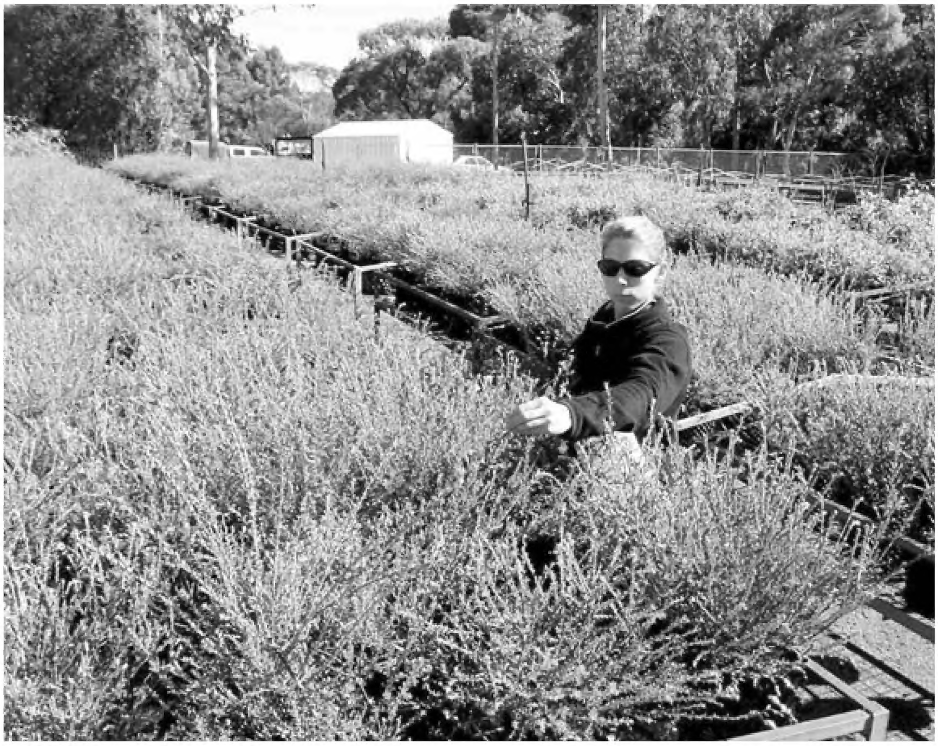

Figure 1: Alcoa's Marrinup Nursery seed orchard. Photo: Alcoa

Why use local provenance seed?

The use of local plants from natural populations for revegetation has many benefits. Generally, in natural communities, plants have evolved to suit local environmental conditions, resulting in better survival and growth (Harwood 1990). Local seeds are likely to be the most suitable and best adapted to local climate regimes (eg. rainfall, frost tolerance, germination temperature), edaphic conditions (eg. soil texture, water holding capacity, chemical composition) and ecological processes (eg. mycorrhizal associations, pollinator abundance, seed dispersers). Alcoa's seed collection and storage strategies have been adjusted to ensure that only provenance correct seed is used for rehabilitation.

Seed storage

Seed production in natural plant populations is highly variable. To guard against poor years, Marrinup Nursery keeps a seed inventory with sufficient seed for at least two rehabilitation seasons (Fig. 2). At any one time, the Nursery may hold up to 5500 kg of seed. Because of this, much emphasis is placed on effective seed storage and quality control to maintain seed viability. Prior to delivery, all seed is dried and species commonly affected by insect predation are treated with the dust insecticide, Dryacide (Entosol Australia Pty Ltd). Seed is stored in airtight containers with a silica gel desiccant bag to remove excess moisture, and kept at 4°C.

Recently, research on the effect of the storage atmosphere (temperature and relative humidity) on seed viability and dormancy has shown that some jarrah forest species benefit from short-term storage at warmer (22°C) temperatures as this helps with seed maturation and after-ripening processes (Peishi *et al*. 1999). Together with the Botanic Gardens and Parks Authority (Kings Park), Marrinup Nursery continues to investigate this requirement in a number of jarrah forest species.

Quality control

Desiccated, cracked, discoloured, mouldy, or predated and empty seed delivered to Marrinup is considered unviable and is not accepted from seed merchants. Seedlot purity is also examined to ensure sufficient seed is present in seedlots with a high proportion of chaff. In cases where seed does not reach quality standards, the seed is returned and replaced by the seed merchant.

Due to the large quantity of seed entering the nursery, it is not possible to conduct a quantitative quality test of all seedlots. Therefore, random samples are taken from each bulk delivery and are cut-tested and sown to determine viability and germination potential (Fig. 3).

Research germination trials are also carried out on species with high viability but consistently low germination rates. Seed treatments such as heat, stratification, smoke water, scarification, gibberellic acid or combinations of these may be applied to break existing seed dormancy. Germination results are used to help predict germination rates in the field. Alcoa also publishes results in journal papers, and Alcoa research notes and bulletins so that it is freely available to the public, landcare groups and other mining companies (see Koch & Taylor 2000).

Top: Figure 2. Alcoa's seed storage area containing five and a half tonnes of native seed for broadcasting.
Bottom: Figure 3. Germination and viability testing is an integral part of quality control at Marrinup Nursery. Germination is tested in nursery beds, in glasshouses and sometimes in incubators. Photos: Alcoa

Through effective seed management and research, Alcoa's Marrinup Nursery is able to consistently supply a large quantity and diversity of native seed. This is an essential requirement for Alcoa's drive to restore a functional jarrah forest ecosystem that fulfils all of the pre-mining land uses of the jarrah forest.

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Seed viability in serotinous species of the Sydney region

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Serotiny is 'the retention of at least part of the seed crop on the plant in the presence of the succeeding crop' (Lamont 1991). Previous studies of seed viability in serotinous species have generally shown a decline in seed viability over time (Table 1). Viability loss of canopy-stored seeds is one constraint to release of a large seed crop and subsequent regeneration in response to fire, heat or drought or other causes of stem or plant death (Lamont and Groom, 1998). Viability decline in serotinous species also has implications if seeds are collected for bush regeneration or seed banking for long term conservation, as highly viable seeds generally result in faster, more uniform germination and a longer lifespan in storage.

This project investigated whether seed stored in the canopy of *Allocasuarina distyla*, *Banksia ericifolia*, *Callistemon pinifolius* and *Hakea gibbosa* maintains its viability over time. All four species are strongly serotinous, retaining a high proportion of seeds on the plant.

Materials and methods

Seeds from cones or fruits of different age classes (cohorts) were collected from a number of plants (usually ten) of each species from the Sydney region. For *Banksia*, two age classes of cones were collected. Young cones were collected from near the tree top on branches less than a few centimetres thick, while old cones were collected on larger main branches. Seeds were removed by burning cones with a flame until follicles started to open. Seeds that did not fall out were extracted from the follicles using forceps. For *Allocasuarina*, six age classes were distinguished, following Pannell and Myerscough (1993), based on the distance from the first fruit on the longest branch: age 1 = 0–25 cm from first fruit, 2 = 26–50 cm, 3 = 51–75 cm, 4 = 76–100 cm, 5 = 101–125 cm, and older >125 cm. *Hakea* seed was collected from three age classes of fruits: 1 = young, with a greenish, glaucous appearance from side branches; 2 = intermediate, from side branches; and 3 = old, from main stem, as low down as possible. For *Callistemon* age classes were determined by counting the number of clusters from the stem apex. Following collection, fruits of *Allocasuarina*, *Callistemon* and *Hakea* were placed in a drying room (approximately 18°C, 15% RH) which facilitated seed release.

Germination tests were conducted on *Allocasuarina* (for each age class, 3 x 20, that is 3 replicates of 20 seeds), *Banksia* (4 x 10), *Hakea* (5 x 10), *Callistemon* (3 x 20). For *Allocasuarina* and *Banksia* the tests were repeated for each individual plant, but due to limitations of the number of seeds available, for *Hakea* and *Callistemon* the tests were carried out on pooled seed across all plants. Seeds were placed in glass petri dishes containing water agar (7g/L), and incubated at 20°C (*Allocasuarina* and *Hakea*) and 25°C (*Banksia* and *Callistemon*) with 12 hours light /12 hours dark. Germination was defined as emergence of the radicle from the seed coat and tests continued until all seed germinated or no seed had germinated for at least two weeks. A germination

Family	Species	Change over time	Seed age compared	Reference
Casuarinaceae	*Allocasuarina distyla*	60% declining to <10%	Years 1 to 12	A
Casuarinaceae	*A. nana*	40% declining to <10%	Years 1 to 12	A
Proteaceae	*Banksia attenuata*	75% declining to 51%	Years 1–3 v 7-9	B
Proteaceae	*B. burdettii*	58% declining to 4%	Year 1 v 9–12	C
Proteaceae	*B. cuneata*	85–98% declining to 50%	Years 1–8 v 9	D
Proteaceae	*B. hookeriana*	None	Years 1 to 12	E
Proteaceae	*B. leptophylla*	96% declining to 65%	Years 7–9 v 10–12	B
Proteaceae	*B. menziesii*	11% declining to 7%	Years 1–3 v 7–9	B
Proteaceae	*B. prionotes*	76% declining to 40%	Years 1–3 v 7–9	B
Proteaceae	*B. tricuspis*	100% declining to 69%, then 18%	Years 1 v 3, and 3 v 4–16	F
Proteaceae	*Hakea gibbosa*	None	Old v young	G
Proteaceae	*H. salicifolia*	97% declining to 0%	Old v young	G
Proteaceae	*H. sericea*	91% declining to 68%	Older age class during one year	H
Proteaceae	*H. sericea*	None	Old v young	G
Proteaceae	*H. suaveolens*	None	Old v young	G
Myrtaceae	*Melaleuca quinquinervia* (dry habitat)	92% declining to 71%, then 60%	Cluster 2 compared to 5 and 7	I

Table 1: Changes in viability of canopy-stored seed over time in previous studies. Viability was estimated using a germination test in all studies. References: A = Pannell & Myerscough (1993), B = Cowling et al. *(1987), C = Lamont & Barker (1988), D = Lamont* et al. *(1991), E = Enright* et al. *(1996), F = Lamont & van Leeuwen (1988), G = Richardson* et al. *(1987), H = Brown & Whelan (1999), I = Rayachhetry* et al. *(1998).*

Top left: Allocasuarina distyla *cones, top right:* Banksia ericifolia *cones, bottom left:* Callistemon pinifolius *capsules, bottom right:* Hakea gibbosa *fruits.*
Photos Leahwyn Seed, Botanic Gardens Trust

test of immature (orange, but fully-sized) and mature (brown) *Allocasuarina* seed was performed using 5 replicates of 20 seeds under the same conditions as the mature seeds.

Results and discussion

Seed maturity

Hakea seed at age class 1 had significantly lower germination (58%) than at ages 2 and 3 (94% and 93%, respectively). These results agree with observations of lower germination in immature seed from another study, where germination of newly set *H. sericea* seeds increased from 0 to 100% between February and April as seed matured (Brown and Whelan 1999). Immature *Allocasuarina* seeds showed no sign of germination and became mouldy during the time that mature seed germinated (8–16 days).

Seed viability decline

In *Banksia* seed, the younger cohort of seed had significantly higher germination than the older cohort (99% compared to 88%). A general trend of loss of seed viability as cones age has been reported in other *Banksia* species (Table 1). In *Callistemon*, seed from years 2, 3, 4 and 5 had similar germination (between 88 and 95%) but seed from years 6 and older had significantly lower germination (68% or lower).

For each of the ten *Allocasuarina* plants tested, there was no significant difference in germination between the six age classes. However, one of the ten plants had significantly lower germination of only 20% compared to at least 60% (and mostly >85%) for the other nine plants. Smoke-water treatment prior to incubation did not significantly alter germination.

As well as reduced viability there may be increased seed predation in older fruit. For example, we found a decline in the number of seeds per fruit in *Hakea*. Age class 1 had, on average, 2.0 seeds/fruit, age class 2 had 1.7 seeds/fruit and age class 3 had 1.1 seeds/fruit.

Implications for seed collection

Optimal seed quality from serotinous species will be achieved if collectors are aware of the age structure of fruits. Care should be taken to collect from mature fruits, avoiding both the most recently set fruit (due to possible immaturity) and the oldest fruit (due to likely reduced viability). Seed losses from predation will also contribute to a declining return in seed collections made from older fruit.

Because some individual plants may have much reduced seed viability compared to other plants of the same species, collections should be made from the greatest number of plants possible, which should buffer the effect that any individual plant makes to the collection.

Acknowledgements

Thanks to Mishy Mckensy and Tracey Armstrong for assistance with seed collection and Robin Probert and Tony Auld for valuable discussions. This work was conducted under the auspices of SeedQuest NSW, in partnership with the Millennium Seed Bank Project Kew, which is supported by the UK Millennium Commission, the Wellcome Trust and Orange plc.

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Can we learn more from fewer seeds?

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Germination, dormancy and factors limiting their investigation

Dormancy is a seed characteristic common among Australian native plants. This block or series of blocks within the seed impedes germination even when there is adequate water and a suitable thermal and gaseous environment for germination (Vleeshouwers *et al.,* 1995). Coupled with dormancy is often a very particular combination of natural factors required to initiate germination. Without knowledge and understanding of these processes, it is difficult to study, regenerate, use (e.g. in degraded land re-vegetation) and conserve (in *ex situ* seed banks), many Australian native plant species.

Australian flora has evolved highly specialised germination requirements in order to survive both this continent's dry climate and other natural phenomena. A practical approach to initiating germination is often to mimic the plant's natural environment. For example, many species require a period of dry and/or high temperature storage before being placed in appropriate germination conditions. Others require the removal or chipping of thick seed coats/fruits. Effective chemical treatments often include the application of smoke solution, potassium nitrate (KNO_3) or gibberellic acid (GA_3).

Australian native perennial herb, Goodenia fascicularis *(Goodeniaceae). Photo: Gemma Hoyle*

Recent research continues to emphasise the importance of multiple and sequential cues to relieve dormancy and initiate germination of Australian flora. Therefore it is often desirable to investigate the simultaneous effects of a combination of different factors. Common initial approaches may include applying a range of different chemical and mechanical treatments to seeds, before sowing at a range of different temperature and light/dark regimes.

There are, however, several factors that limit investigation of dormancy and germination requirements of previously unstudied plants. These can include quantity and quality of available seed, as well as staff and time resources. With these limitations in mind, is it possible to improve the efficiency of investigation without compromising on information gleaned?

Using only a *fraction* of the 'full factorial' experimental design

The 'design of experiment' (DOE) is crucial when preparing to investigate dormancy, germination, and potentially influential factors. The 'full factorial' experimental design allows the investigation of many factors in order to identify the more important factors and interactions between factors, i.e. the effect of one treatment may depend upon another treatment. The total number of combinations is equal to the number of *levels* investigated, raised to the power of the number of *factors*. For example, a full 2^4 factorial investigates the effects of every combination of 4 factors (one factor being application of GA_3 for example), each at 2 different levels (e.g. concentrations), and therefore involves a total of 16 different treatments.

The full factorial might be considered optimal if time, energy and experimental units (in our case seeds), are not limiting. However, the number of seeds necessary for such experiments increases geometrically with the number of factors studied. For example, assuming 100 seeds per treatment, a 2^2 factorial would require 400 seeds, a 2^3 factorial 800 seeds and a 2^4 factorial 1,600 seeds, etc. In practice, seed numbers are often extremely restricted, particularly those of collections made for conservation purposes, and/or of rare and endangered species. Experiments of this magnitude are also a huge drain on time and resources.

One way to reduce the number of seeds involved may be to use a '*fractional* factorial' DOE, which only uses one-half, one-quarter or an even smaller fraction of the full 2^n treatment combination (Kuehl, 2000). This kind of DOE assumes that only a few effects (and interactions) are

Australian native annual daisy, Actinobole uliginosum *(Asteraceae). Photo: Gemma Hoyle*

large and of significance, which is often the case in the application of seed dormancy-relieving treatments and germination cues. However, despite its potential to save thousands of seeds, this approach has not previously been applied to seed germination/dormancy studies.

Taguchi analysis

The Japanese engineer Dr. Genichi Taguchi is responsible for what is commonly known as the *Taguchi method*, or *Taguchi analysis*. This is a special application and analysis of the fractional factorial, aimed at achieving maximum information from minimum effort and resources (Roy, 2001).

Traditionally, the average (or mean) effects of factors are calculated in order to determine the optimum factor(s)/level(s), through the application of analysis of variance (or ANOVA). However, this does not capture the variability of data within the results. In contrast, Taguchi analysis does not use the mean percentage germination, but instead uses a 'signal to noise ratio' (or SNR, a log transformation of the mean-squared deviation), as the yardstick for analysis of results, which incorporates both the effects of changes in mean as well as the variation i.e. how *consistent* the effect of the treatment is. In theory this would reveal which factor(s) are having the greatest effect on achieving a target value, in our case 100 % germination.

The economic potential for Australian native seeds

The traditional full factorial DOE is currently being used to study seed germination of the physiologically dormant native forbs *Goodenia fascicularis* and *Actinobole uliginosum*. The effects of, and interactions between dry after-ripening, light and application of GA_3 and smoke solution on dormancy/germination will be investigated. We will be analysing the data generated using both the traditional ANOVA approach and the Taguchi method. A fraction of this full factorial, designed using a set of tables known as *orthogonal arrays*, will also be analysed.

Designing experiments using the fractional factorial combined with Taguchi analysis has the potential to be beneficial in a number of ways:

- the number of seeds used to obtain data that is not significantly different from that generated by much larger, full factorial experiments, could be greatly reduced. For example, assuming 100 seeds per treatment, a fraction of the 2^4 factorial would save 800 seeds, a fraction of the 2^5 factorial would save 2,400 seeds!;
- main effects and low-order interactions concerning germination requirements and dormancy alleviation may be obtained from simpler routine investigations, adding value to data generated by initial screening, particularly of previously unstudied species; and
- Taguchi analysis may also be used to determine the combination of factors required to optimise a response variable such as germination rate (Staines *et al*., 1998).

This research forms part of a PhD studentship under the supervision of Dr. Matthew Daws (MSBP, UK), Dr. Kathryn Steadman (Murdoch University, WA) and Assoc. Prof Steve Adkins (University of Queensland). Work has been made possible due to the generous financial support of the Australian Mining Industry, the Millenium Seed Bank Project and the University of Queensland. In summary, it is hoped that this work will uncover a useful, more economic method of gleaning preliminary information about germination requirements and dormancy relieving treatments of previously unstudied Australian native plant species.

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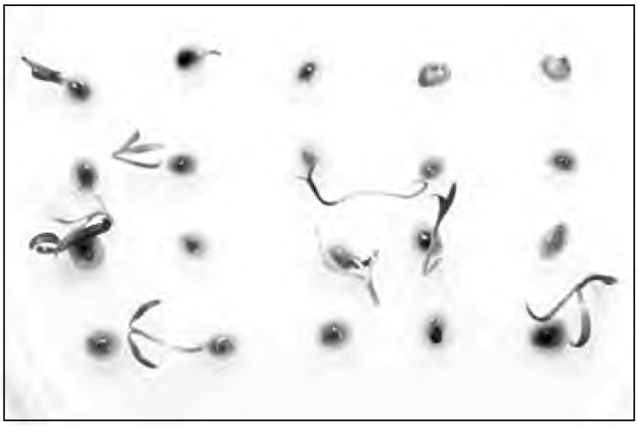

Seeds and seedlings of the physiologically dormant Goodenia fascicularis *(Goodeniaceae). Photo: Gemma Hoyle*

Seeds and the survival of the Southern Shepherd's Purse

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The Southern Shepherd's Purse, *Ballantinia antipoda* (Brassicaceae), is a small, cool-season annual herb which grows in fragile, seasonally moist moss mats. It was presumed extinct until re-discovered on Mount Alexander, Victoria, in 1983. This species is currently known only from a number of granite outcrops within the Mount Alexander Regional Park, in Central Victoria and is listed as Endangered under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, and as threatened under the Victorian Flora and *Fauna Guarantee Act 1988*.

Seeds and *ex situ* conservation

Southern Shepherd's Purse produces fruit with two halves each containing 2–6 small seeds. At maturity the two valves of the fruit typically separate and disperse their seed passively via the wind or with an explosive force. Seeds are produced in late September to early October with a continual release of seeds until late October. Seed production is dependent on moisture in the moss mats that the plant inhabits. If the moss mats dry out early in the season the Southern Shepherd's Purse will prematurely die off. If this occurs the plant will rapidly produce seed that may or may not be viable after desiccation, further reducing the seed bank for the following growing season.

There is a real possibility that this species will be extinct in the near future if steps are not taken to save it. "So what can we do about it you ask?" An *ex situ* population has been established at Royal Botanical Gardens Melbourne. These propagated plants are currently being used as a seed source for the Millennium Seed Bank Project. In the event of a fire at the mountain or another catastrophe, these plants may also be reintroduced into the wild, while keeping others as a seed source for future translocations.

Management of the natural populations

Natural populations of Southern Shepherd's Purse are currently being protected, managed and monitored with help from various groups and the cooperation of Parks Victoria.

In recent years there have been 4-5 moss matt rehabilitation works conducted within the regional park by David Meagher (a bryologist) and Jenni Thomas (Department of Sustainability and Environment (DSE) Native Vegetation Officer). The various rehabilitation sites will be monitored until 2010.

Within the next month further rehabilitation works will occur to restore recent damage that was made due to localised construction works. Some of the activities planned for the rehabilitation will be woody weed removal, native flora plantings, track works and monitoring. These activities will be conducted with the help of a combination of groups such as the International Student Exchange participants, Harcourt Landcare Group, Parks Victoria and the DSE Biodiversity Group.

A rabbit control program will also be put into action in the near future. Rabbits have been very detrimental to the habitat of Southern Shepherd's Purse. They dig up the moss pads and add a nutrient load to sites. It is also suspected they graze on the Southern Shepherd's Purse and other flora species.

It is hoped that, with the help of various agencies and groups, the Southern Shepherd's purse will be safe and move towards a stable status in the future.

Further reading

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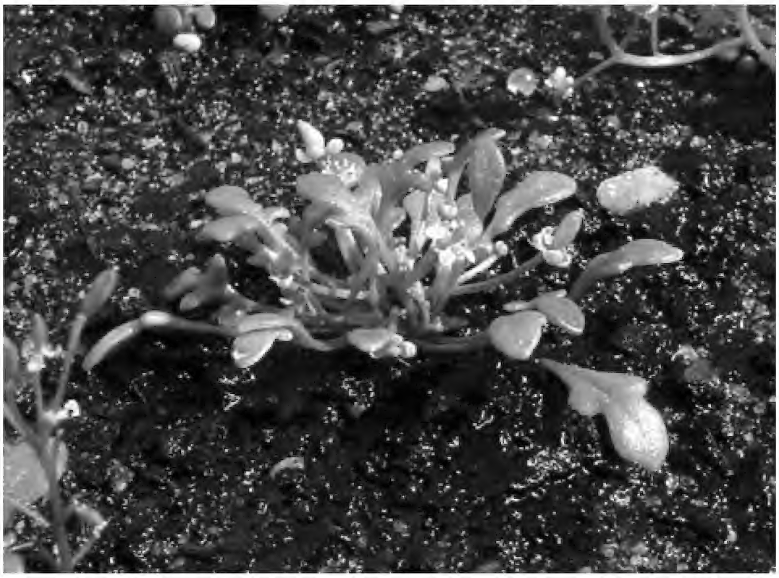

An ex situ *Southern Shepherd's Purse plant, depicting the typical rosette habit and spoon-shaped leaves. This plant is one of numerous propagated plants being used as a seed source for the Millennium Seed Bank Project. Photo: Jeremy Prentice*

A seedbank for threatened species

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With its international standing as a biodiversity hotspot, south west Western Australia has a rich diversity of plant species. Of the 5710 species found in the region 3000 species, or 52.5 per cent, are endemic (Beard *et al.,* 2000). This rich endemism is facing an uncertain future, with introduced pests and diseases, land degradation and climate change threatening the very fabric of the natural environment.

In 1992, some 20 per cent of south west flora was considered susceptible to the virulent fungal pathogen, *Phytophthora cinnamomi* (Wills pers. com.). Since that time, the risk of species and population decline has multiplied and the future of the flora looks exceedingly bleak. Today, more than 40 per cent of that same suite of species is considered susceptible (Shearer *et al.* 2004). Despite application of the fungicide Phosphite, populations of some highly susceptible species continue to decline. In addition, changes in hydrology are causing large tracts of land to become unsustainable. An estimated 16 per cent of the south west region has a high potential of developing salinity from shallow water tables. This is predicted to rise to 33 per cent by 2050 (http://www.nht.gov.au/publications/journal/nht14/salinity-wa.html).

This year the Department of Environment and Conservation listed 372 threatened taxa with Declared Rare Flora Status; all but 19 of these occur in the south west region. A further 2246 taxa are listed as Priority for conservation, almost 80 per cent of these occurring in the south west. In addition to single species listings, there are more than 85 Threatened Ecological Communities and eight nationally recognised Biodiversity Hotspots registered in Western Australia, many occurring in the south west. Without a doubt, large portions of the flora are facing an extinction crisis.

As the number of threatened species escalates, integrated strategies that protect the flora are becoming more essential. In late 1992, the Department of Conservation and Land Management, CALM (now Department of Environment and Conservation, DEC) judiciously adopted seed conservation as one strategy aimed at countering the erosion of diversity. The conservation of seeds represents an efficient and cost-effective method of conserving the variation within and between individual flowering species and permits a broader genetic representation than would be possible with living plant collections. In 2001 Western Australia joined an international seed conservation initiative, the Millennium Seed Bank Project (MSBP) of the Royal Botanic Gardens Kew, UK. Both DEC and the Botanic Garden and Parks Authority in Perth became partners in this project. Support to DEC's Threatened Flora Seed Centre has seen a significant growth in the incorporation of both accessions and taxa of threatened flora (Fig. 1).

Currently the Threatened Flora Seed Centre holds 2052 collections of seed in protective custody (Figs 2-3). These collections represent 1014 taxa from 181 genera spread over 55 families. Almost a quarter of these collections are from gazetted Declared Rare Flora, representing 63 per cent of the extant threatened flora of Western Australia. This includes 71 per cent of the Critically Endangered flora, three species of which have already lost populations to the pathogen *Phytophthora cinnamomi*. A further 50 per cent of collections come from the State's Priority or poorly known flora. The remaining collections come from flora associated with Threatened Ecological Communities or Biodiversity Hotspots. More than 300 of the taxa have multiple accessions, and some individual species have as many as 26 collections.

Supporting species survival in the wild is the primary objective of seed conservation at the Threatened Flora Seed

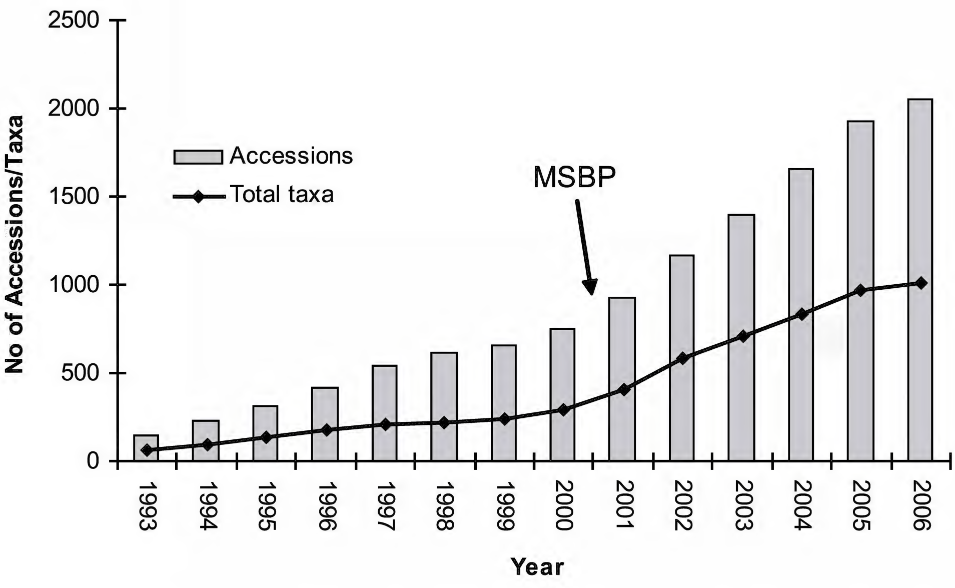

Figure 1. Accessions and taxa incorporated into the Threatened Flora Seed Centre since 1993. Note the increase in both taxa and accessions since the partnership with the Millennium Seed Bank Project (MSBP).

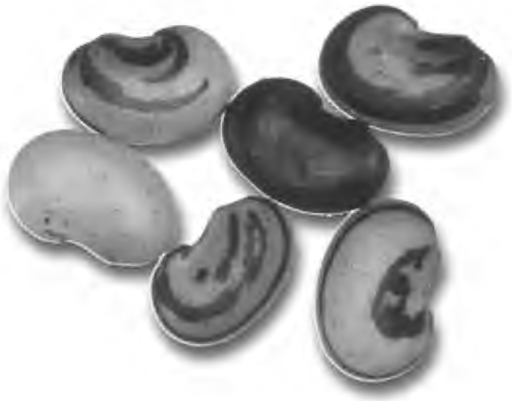

Figure 2. Seed of the critically endangered Jacksonia pungens. *Photo: Anne Cochrane*

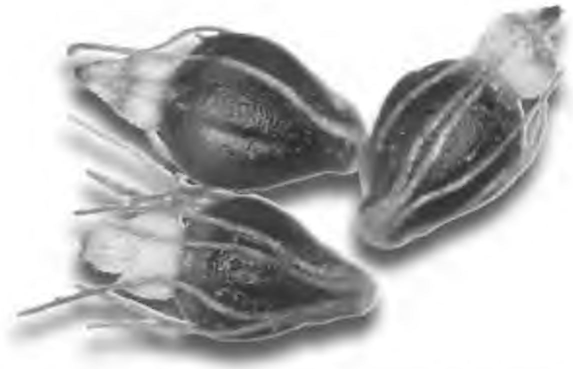

Figure 3. Seed of the vulnerable Eleocharis keigheryi. *Photo: Anne Cochrane*

Centre and material in protective custody is held for recovery or research aimed at more effective conservation outcomes. Samples of seed are used for investigations into germination and storage behaviour and seedlings are used in studies that reveal the susceptibility of species to *P. cinnamomi*. More importantly, material is used for the reintroduction of threatened species into the wild and, in some extreme cases, for the establishment of seed production areas for critically threatened species.

With both international and Commonwealth support for seed conservation, not only in Western Australia, but throughout Australia, the numbers of species incorporated into protective custody will rise to almost a quarter of the total goal of the MSBP by 2010, namely the conservation of 10 per cent of the world's dryland flora. Australia is actively contributing to the Global Strategy for Plant Conservation through its seed conservation activities and its support to threatened species survival. In undertaking this task, Australia is helping to ensure that future generations can enjoy of the benefits of a rich floral diversity.

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News from Australian partners – Millennium Seed Bank Coordinator

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There is now a seed bank programme in each state of Australia set up in partnership with the Millennium Seed Bank (MSB), whose headquarters are at Wakehurst Place, Sussex, UK. Some of these seed banks are new initiatives, others have been established for some time. Funded by the Royal Botanic Gardens, Kew, the Millennium Seed Bank Coordinator is a newly created position to help raise the profile of MSB partners in Australia and facilitate greater collaboration between the state operations. I have recently been appointed to the position and will be working from Kings Park and Botanic Gardens, Perth.

Each state is very different in the size of its seed bank team and operation but the fundamental strategy is the same. At the heart of each project is the collection of seed from endemic endangered and threatened species for conservation at the Millennium Seed Bank at Wakehurst Place and within each states' own stores. This seed then provides the material for further research and conservation objectives.

It is nice to know that out of all the MSB projects, Australia receives a third of the budgeting allocation, as we contribute nearly a third of all accessions to the MSB. This isn't including the value-adding that the MSB Australian partners provide in training and research.

Training programmes have been an integral part of the MSB partnership, with, for example, South Australia and Victoria training Departmental staff in seed collection and developing a volunteer base. Greening Australia in Queensland has run similar workshops that have helped with identifying collection areas and timing of collections.

At a professional level, MSB partners ran seed conservation workshops at various locations around the country over the last year. Typical topics included seed banking as a conservation tool, seed dormancy and seed morphology. All these workshops were well attended and contributed greatly to MSB partners advancing seed science in Australia.

In conjunction with training here in Australia, the MSB provides opportunities for staff and scientists to travel to Wakehurst for training and to work with their science and technical staff.

At present the research teams in each state are focussed on projects such as native seed viability, the factors that inhibit or affect germination, optimising collection quality, longevity of canopy stored seed, the storage capability of recalcitrant seed and studies on orchid seed and their associated myccorhizas.

This is just a brief overview of the work being undertaken around Australia by dedicated teams of seed conservationists. The MSB funding has provided us with the impetus and a unique opportunity to further our knowledge on Australian species and ensure we have a chance of conserving our singular flora.

Part of my role is to engender a feeling of urgency in our funding bodies so that they see how important the long-term strategy of *ex situ* plant conservation is to our environmental health. With luck this will ensure that there is a strategy in place so that the valuable work started by the MSB project in this decade continues into the next.

Millennium Seed Bank programmes in Australia

- **New South Wales**: SeedQuest NSW http://www.rbgsyd.nsw.gov.au/conservation_research/plant_conservation/nsw_seedbank/seedquest_nsw
- **Northern Territory**: http://www.nt.gov.au/ocm/media_releases/2004/20041124_cb_Kewgardens.shtml
- **Queensland**: Seeds for Life http://www.greeningaustralia.org.au/GA/QLD/OnGroundAction/our+projects/sfl/
- **South Australia**: Seed Conservation Centre http://www.denr.sa.gov.au/botanicgardens/seed_conservation.html
- **Tasmania**: Tasmanian Seed Conservation Centre http://www.rtbg.tas.gov.au/tas_seed_conservation.html
- **Victoria**: Victorian Conservation Seedbank http://www.rbg.vic.gov.au/research_and_conservation/seedbank
- **Western Australia**: Threatened Flora Seed Centre http://www.calm.wa.gov.au/science/tfsc_splash.html Seeds of Life: http://www.bgpa.wa.gov.au/science/seedsoflife.html?Menu=science

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Seeds for Survival

Ben Cavuoto

Greening Australia, ACT. Email: bcavuoto@act.greeningaustralia.org.au

The Seeds for Survival project was initiated after the 2003 ACT bushfires to increase availability and diversity of local native seed to the wider community. The project aims to address the medium and long-term native seed supply needs of the ACT and region. The project is funded by the ACT Government and the Australian Government through its Natural Heritage Trust program. Project partners include Environment ACT, Australian National Botanic Gardens (ANBG), CSIRO Plant Industry, Canberra Urban Parks and Places, and Greening Australia ACT & SE NSW.

The project aims will be achieved via the:

- identification of healthy remnant vegetation seed collection sites;
- identification of existing revegetation project sites;
- establishment of new seed production areas;
- coordination of local native seed collection;
- and through education and training.

To meet the high demand for high quality local provenance seed, Greening Australia works closely with ANBG staff at the ANBG facilities to dry, clean, test, store, data base and dispatch provenance native seed. In order to help overcome seed supply shortages, a network of regionally skilled seed collectors is also being established.

The design of new seed production areas is currently being researched in consultation with CSIRO Plant Industry and natural resource management stakeholders. Selected sites will be mapped using a Geographical Information System database and a photo point monitoring program will be established to research seed production yields, wildlife habitat and biodiversity.

Through a series of training programs and field collection days, the project aims to educate and create awareness about the collection of provenance native seed among community volunteers, seed collectors, private landholders, rangers, school groups and universities. For example, Greening Australia ACT & SE NSW has designed the Seeds for Survival workshop to show individuals how to collect, dry, clean and store native seed using ethical and legal best practices. Greening Australia ACT & SE NSW also held a forum in May 2006 entitled 'Serious About Seed', which attracted 115 people from all walks of life to discuss native seed production areas.

The project team is also working closely with staff at Greening Australia in the revision of FloraBank. The Australian Government has committed funding from the Natural Heritage Trust to revive the FloraBank project. FloraBank2 will start with a revision of the website (www.florabank.org.au) to create an information hub for all aspects of native seed. ENSIS, a joint venture between CSIRO and Scion (a New Zealand forest research group), will assist with the development of powerful information management tools to create stronger links amongst the native seed sector and between the native seed supply sector and research. FloraBank will also develop a nationally-accredited native seed training package which registered training organisations can deliver throughout Australia. Greening Australia will coordinate the project. We look forward to providing some coordination to the diverse range of projects, organisations and individuals involved with native seed in Australia.

In summary, the future of the Seeds for Survival project will inevitably engage the ACT community at large in native seed identification, collection and distribution and will result in the sharing of vital knowledge associated with seed collection techniques, ethical considerations, conservation enhancement, technical information, and cultural history.

Top: Rangers and Friends of Tidbinbilla Nature Reserve collecting Hakea microcarpa *seed. Photo: Ben Cavuoto*
Bottom: Workshop participants learning how to identify native seed at the Australian National Botanic Gardens. Photo: Robert Gardiner

Follow up to biodiversity conservation on church-owned land

Steve Douglas

8 Benny Place, Chisholm, ACT, 2905. Email: stevemd@bigpond.net.au

Following from my article published in *Australasian Plant Conservation* 14(3) about biodiversity conservation on church-owned land, I can report that, as a result of undertaking a volunteer-based survey of the St Clements Retreat, the remnant vegetation was confirmed as the endangered 'box-gum woodland' community. St Clements Retreat is a former Catholic monastery at Galong, between Harden and Yass in the NSW Southern Tablelands / South West Slopes area.

At the site, old hollow-bearing trees were recorded, as was a population of the vulnerable Superb Parrot. The survey also resulted in confirmation of a significant range extension for the endangered *Cullen parvum*. This is a very important finding because *C. parvum* was previously known from fewer than five records in NSW, all further south and west in the South West Slopes / Riverina area. Most herbarium collections of the species are very old. The species also occurs in Victoria and SA.

The Catholic Church has indicated its intention to have the entire property of approximately 240 hectares (600 acres) declared a Wildlife Refuge, with plans to enact a perpetually binding Voluntary Conservation Agreement over the woodland area, inclusive of the *Cullen*. It is hoped that further such surveys and collaborations between field naturalist groups and Church land managers will lead to other exciting discoveries and the formal protection of additional ecological assets.

I acknowledge the contributions of members of the Australian Native Plants Society (ANPS) Canberra Region's Wednesday Walkers group, Margaret Ning of Friends of Grasslands, and Dave Mallinson of the Australian National Herbarium.

ANPS and Friends of Grasslands volunteers in Cullen parvum *habitat at St Clements Retreat, Galong. The* Cullen *is threatened by pasture weeds and sown pasture species. Photo: Graeme Kruse*

Report from New Zealand Plant Conservation Network

Bec Stanley

Email: rebecca.stanley@arc.govt.nz

The Network delivered its first marae-based plant training course in Northland at the start of the year. Hosted by a local hapu (Ngati Hine) this two-day course is the first of its kind teaching students how to recognise and identify native plants. This was done through hands on teaching and bush walks to meet plants face-to-face. A work book on basic botany and plant identification was developed for the student to accompany the course. A follow up course in March reinforced what was learnt at the first course and students received their certificates. More modules are planned for development and delivery over the coming months including managing Nga Whenua Rahui covenants, streamside restoration, and cultivation of native plants.

Students and tutors at the marae-based training course, Northland. Photo: John Sawyer

Ongoing projects include consultation on criteria for our Important Plant Areas project. We held a workshop at our Christchurch conference in 2005 to draft the criteria to identify a network of sites within each biogeographic zone in New Zealand and throughout Oceania, that are critical for the long-term viability of naturally occurring wild plant populations. We're also conducting New Zealand's first comprehensive stocktake of plant conservation education resources and programmes. We aim to create a searchable database that lists all existing plant conservation education resources and programmes nationally.

Our website continues to attract more visitors with over 650,000 hits per month which equates to around 24,000 visitors. This makes the Network by far the largest NGO for plant conservation in New Zealand. The website is now the largest publicly accessible collection of plant images in NZ helping everyone to identify and learn more about our precious native flora.

We are building up to our next conference in Auckland in November. This year's Network conference will be the Cheeseman Symposium 2006 – to celebrate the centenary of the publication of the first full flora treatment published by a resident New Zealand botanist, Thomas F. Cheeseman's *Manual of the New Zealand Flora* (1906). ANPC President Judy West will be giving a key note address. ANPC members are all welcome - see Network website for details (www.nzpcn.org.nz). The conference will be held in conjunction with the New Zealand Botanical Society, Auckland Museum, Auckland Botanical Society, Landcare Research and the University of Auckland.

View *Trilepidea*, the E-Newsletter of the New Zealand Plant Conservation Network.

May 2006
http://www.nzpcn.org.nz/Documents/Trilepidea-18-0605.pdf

June 2006
http://www.nzpcn.org.nz/Documents/Trilepidea-20-0606.pdf

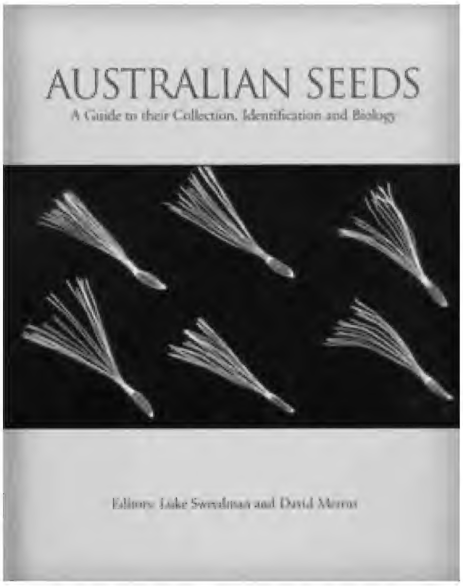
July 2006
http://www.nzpcn.org.nz/Documents/Trilepidea-12-0607.pdf

Book Reviews

Australian Seeds: A Guide to their Collection, Identification and Biology

By L. Sweedman and D. Merritt (Editors)

CSIRO Publishing, Collingwood, 2006. 258 pages.
ISBN: 0 643 09132 7. Price $99.95. To order visit: www.publish.csiro.au


AUSTRALIAN SEEDS
A Guide to their Collection, Identification and Biology
Editors: Luke Sweedman and David Merritt

We now know that it is possible to store seeds successfully from a large proportion of the world's higher plants for many decades, if not for hundreds of years. This breakthrough has led to a worldwide interest in seed banking as a conservation tool. The technique is relatively cheap and allows the possibility of storing an enormous quantity of biodiversity in a fairly small space. This interest in seed banking has spawned a proliferation of literature on seeds and their biology into which this current volume takes a very worthy position.

The first 66 pages of *Australian Seeds* is a collection of essays covering many aspects of seeds including their evolution, structure, biology, ecology, collection, cleaning, drying, testing and storage. The authors of the various chapters are acknowledged experts in their fields and the text is easy to understand. The bulk of the book, some 105 pages, presents colour photographs of seeds from 1,260 species of mostly Western Australian plants. The final section outlines collection guidelines for common Australian plant families and genera. Appendices include seed germination records for over 2,200 Australian native plant species, voucher numbers for the seed photographs, and lists of common and botanical names.

The book takes us through all the steps from planning a field trip for seed collection to their final placement in a long-term seed storage facility. Colour photographs accompany each chapter, depicting collection methods, cleaning and storage equipment, translocation programs and several close ups of seed-testing procedures. There are useful line drawings showing the structure of several types of seeds and the most commonly encountered fruits.

Unfortunately the book's greatest strength, the extensive research into the fruits and seeds of Western Australian species, is overlooked in its title: perhaps *Western Australian Seeds* would be more apt? Apart from the first eight chapters, which give a wealth of information applicable to seed banking virtually anywhere, the book has an almost exclusively Western Australian focus. To give the book a truly Australian context, it would have been necessary to include mention of some of the uniquely eastern Australian genera. Also desirable would have been inclusion of iconic eastern species such as *Banksia ericifolia*, *Doryanthes excelsa*, *Epacris impressa*, *Eucalyptus regnans*, *Grevillea robusta*, *Nothofagus cunninghamii* and *Telopea speciosissima*.

It is a shame that so little attention is afforded the large and important family Orchidaceae, which contains many of our most threatened species that would benefit enormously from seed banking. Most members of the Orchidaceae (and many other deciduous perennials) are unidentifiable in the field at the fruiting stage, so collecting seeds from these plants requires special techniques.

For the general reader, this is an informative overview of the intricacies of seed collection, identification and biology. The photographic guide is evidence of the beauty of seeds, which is sadly so often overlooked in popular horticultural media in favour of its floral precursor. For those involved in seed collection, the chapters covering collection, drying and cleaning, and seed storage and testing, although covered in other literature, make for invaluable reading, and are accompanied by high quality colour photographs. The images of the seed cleaning and drying set ups in Western Australia, Tanzania and the United Kingdom remind the reader of the global necessity for *ex situ* seed conservation.

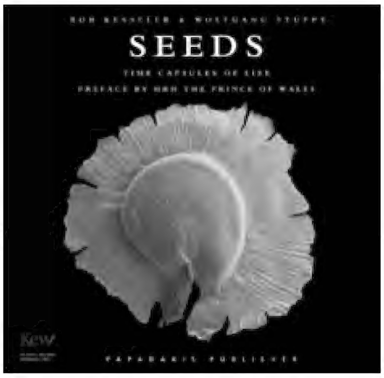
This volume is a valuable addition to the literature pertaining to Australian seeds. Anyone wishing to set up and run a successful seed bank, whether for commercial or conservation reasons, will find all the information they need in this volume. At $99.95 it is rather expensive and we can only hope that when the paperback version becomes available it is more affordable.

Jeff Jeanes and Megan Hirst, *Victorian Conservation Seed Bank, Royal Botanic Gardens Melbourne.*

Seeds: Time Capsules of Life

By Rob Kesseler and Wolfgang Stuppy

Papadakis Publisher, London, 2006. 264 pages, numerous colour illustrations. ISBN 1901092666. Price £35.
To order visit: www.papadakis.net


ROB KESSELER & WOLFGANG STUPPY
SEEDS
TIME CAPSULES OF LIFE
PREFACE BY HRH THE PRINCE OF WALES
Kew
PAPADAKIS PUBLISHER

Next time you collect or plant a seed take a closer look, you could have the template for an eighth wonder of the world in your hand. From the Seychelles Nut which can weigh up to 20 kg to Orchid seed where 1 g can contain two million seeds, 'Seeds: Time Capsules of Life' presents us with the unique beauty and intricacy of its topic. The architectural detail of seeds has become fascinating.

Following on from his other masterpiece 'Pollen, The Hidden Sexuality of Flowers', Rob Kesseler has teamed with Wolfgang Stuppy to produce a work that is visually spectacular and also rates as a first class text for seed biology and ecology.

Rob Kesseler is an artist whose work with the scanning electron microscope has produced the fine detailed photographs presented in the book. He is Professor at the Central St Martin College of Art and Design, and in 2001 he was appointed National Endowment for Science, Technology and the Arts Fellow at the Royal Botanic Gardens, Kew.

Dr Wolfgang Stuppy is the seed morphologist at the Millennium Seed Bank Project where he has been since 2002. The Millennium Seed Bank is an initiative of the Seed Conservation Department at Royal Botanic Gardens, Kew. The depth of Wolfgang's' knowledge and skill became clear when he told me it only took seven months to produce the book.

The collaboration between artist and scientist has clearly worked as seen in the quality and breadth of coverage of the subject. Seeds reflect the range of diversity found in the natural world, where diversity is a mechanism for the sustainability of all life through adaptation to environment. As a plant restoration practitioner it is necessary to have an understanding of how seeds behave and are dispersed as a factor in site planning for revegetation. To know that some legumes manage to eject their seed over a distance of 60 m or that others, like Australian Corkscrew Spear-Grass, will drill themselves into the ground (or passing animal) helps to determine methods of rehabilitation.

For Australians there are quite a few relevant references and photographed Australian seeds (see cover). With a trip through evolutionary history Wolfgang describes the development of some our unique flora. From cycads to daisies, gymnosperms to angiosperms, the development of plant reproduction is amazing. The wonder of its produce is understandable when linked with the 'sexual reproduction so sophisticated' that is involved in the act of 'vegetable love making'.

I really enjoyed the connection made between structures in the natural world and man made architecture. To see how we mimic natural structures in plants to build some of our most iconic buildings underlines how good nature is at design.

The only disappointment for me is the knowledge that the seeds in real life don't display the colour as shown in these photographs. However the detail and morphology of the seeds selected for illustration have been made all the more remarkable because of the tinting. The book is inspiring for the breadth of information in both text and photograph and because it is on such a definitive subject, seeds.

Unfortunately with such a beautifully presented book it is hard not to leave fingerprints all over it, you may choose to handle it with gloves!

Tom North *Kings Park and Botanic Garden, West Perth, WA. Email: tnorth@bgpa.wa.gov.au*

Research Roundup

Briggs, S.V. (2006). **Integrating policy and science in natural resources: why so difficult?** *Ecological Management & Restoration* 7(1): 37-39.

Butler, D.W., Fairfax, R.J. and Fensham, R.J. (2006). **Impacts of tree invasion on floristic composition of subtropical grasslands on the Bunya Mountains, Australia.** *Australian Journal of Botany* 54(3): 261-270.

Clarke, S. and French, K. (2005). **Germination response to heat and smoke of 22 Poaceae species from grassy woodlands.** *Australian Journal of Botany* 53(5): 445-454.

Cowell, S. and Williams, C. (2006). **Conservation through buyer-diversity: a key role for not-for-profit organizations in Australia.** *Ecological Management & Restoration* 7(1): 5-20.

Fensham, R.J. and Fairfax, R.J. (2006). **Can burning restrict eucalypt invasion on grassy balds?** *Austral Ecology* 31(3): 317-325.

Fitzhardinge, G. (2006). **Landcare and private conservation trusts: fertile common ground.** *Ecological Management & Restoration* 7(1): 3-4.

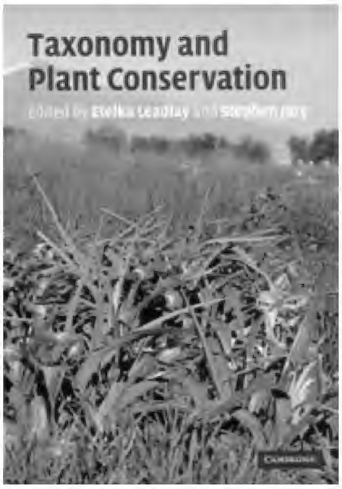
Morgan, J.W. and Scacco, P.J. (2006). **Planting designs in ecological restoration: insights from the Button Wrinklewort.** *Ecological Management & Restoration* 7(1): 51-54.

Tierney, D.A. (2006). **The effect of fire-related germination cues on the germination of a declining forest understorey species.** *Australian Journal of Botany* 54(3): 297-303.

Information resources and useful websites

Taxonomy and Plant Conservation

E. Leadley and S. Jury (eds), 2006,
Cambridge University Press, Cambridge



This volume consists of 21 chapters by a variety of authors around the theme of the critical role played by taxonomy in the conservation and sustainable use of plant diversity. The book is a tribute to British plant taxonomist and conservationist Vernon Heywood. It has a European focus, but covers a range of issues that are of general relevance. Some chapters provide succinct introductions to topics such as principles and practice of plant taxonomy, chemosystematics and plant conservation, measuring diversity, and molecular systematics for measuring and monitoring plant diversity. Other chapters deal with plant taxonomy in relation to reintroduction, seed banks and conservation of taxonomically difficult plant groups. The contribution of Botanic Gardens to plant conservation is touched on in several chapters. A chapter on conservation of island floras has some intriguing section headings such as 'Everything is vague to a degree that you do not realize until you have tried to make it precise' [this in relation to species boundaries]. The book concludes with a chapter on 'Good networks: supporting the infrastructure for taxonomy and conservation'. ISBN 0521845068 (hardback), 0521607205 (paperback). 366 pages. RRP £70.

Special issue on vegetation condition

Ecological Management & Restoration, Volume 7, Issue s1, June 2006, http://www.blackwell-synergy.com/toc/emr/7/s1;jsessionid=e-kbA1HrgqO4cgBOZV

Includes 23 articles arising from a workshop on 'Mapping vegetation condition in the context of biodiversity conservation' held at CSIRO Sustainable Ecosystems in Canberra, Australia, in August 2005.

NRM website for Local Government

http://www.coastalzone.org.au/lg

The Coastal Cooperative Research Centre (CRC) has launched a new webpage which provides information to assist local governments in the management of natural resources. The information is provided in the form of a series of 'factsheets' and 'capability matrices' which provide relevant information on a range of important management issues (e.g. foreshore management) and highlight some practical tools and technologies (e.g. modelling, monitoring) available to manage them. Feedback on the website can be provided to: coastal.crc@nrm.qld.gov.au.

The Coastal CRC completed its activities on 30 June 2006, but the website will continue to be accessible for at least two years. Information on the research carried out by the Coastal CRC during its seven years of operation can be found at http://www.coastalzone.org.au.

Seedheads in the Garden

Noel Kingsbury, August 2006, Timber Press

From the publisher: "Seedheads bring impact to late summer borders and linger to provide interest well into autumn and winter. They look dramatic set against a backdrop of fading flowers ... and are a key component of the naturalistic garden in which every phase of a plant is enjoyed from first shoot to final decay." This book from North America highlights the beauty and impact of seed heads. Many Australian native plants, where seeds linger for years, could no doubt be used to similar effect. ISBN 0881927962. 144 pages. RRP: US$49.95.

Seeds for Life

http://www.greeningaustralia.org.au/GA/QLD/OnGroundAction/our+projects/sfl/

Seeds for Life (SfL) is a joint venture between the Millennium Seed Bank (MSB), a project of the Royal Botanic Gardens, Kew in the United Kingdom, and a number of Queensland research, non-government organisations and government bodies, collectively called the Q-Seed Partnership. The purpose of the joint venture is to improve the conservation of plant biodiversity through researching the restoration of species and ecosystems and to establish long-term conservation collections of seed from priority species from Queensland. Over a six year timeframe, the SfL project will collect at least 1,000 species as seed for storage at both the MSB and in Queensland, and conduct research into seed quality, storage, and restoration programs.

How to get the good seed

Land for Wildlife Queensland Summer 2006, p. 16

Brief article on topics such as timing of seed collection, the 'cut test' to assess seed quality, and setting safe limits to seed collection.

Seed Dormancy Recommendations

Baskin, C.C. & Baskin, J.M. (2003). Overview and recommendations for future research priorities on native seed dormancy and germination of Australian plants. Australasian Plant Conservation 11(4): 2-9.

This paper is from a few years back, but is still relevant to the theme of this issue. It includes a key to dormancy classes and sketches of embryos from seeds of various Australian plants.

Seed Conservation: Turning Science into Practice

R.D. Smith, J.B. Dickie, S.H. Linington, H.W. Pritchard and R.J. Probert (eds), 2003, Kew Publishing

According to the publisher "A landmark review of the current scientific knowledge that underpins seed banking - a technology which plays a key role in the conservation of both domesticated wild plant species. The book is the outcome of a workshop in 2001 hosted at Wakehurst Place by the Millennium Seed Bank Project, and reflects international collaboration on the seed conservation of wild plant species. There are 56 chapters divided into 3 sections: planning and collecting, seed processing and testing, and seed storage and utilisation." ISBN 842460528. 1,056 pages. RRP £59.95.

See also review in *Australasian Plant Conservation* 13(1).

The Australian Seedsman

Harold Grant, no date, published by the author,
90 Wingewarra St, Dubbo, NSW 2830.

An interesting and informative book that recounts the experiences of long-time seed collector Harold Grant, active mainly on the Central Western Slopes and Plains of New South Wales. Clearly laid out, with 50 colour illustrations of plants and seed-collecting and seed-cleaning equipment, with much practical advice based on first-hand experiences. The two main sections are on various methods of collection and cleaning. Each of these sections has examples from native species across a range of plant families. ISBN 0-646-43516-7. 192 pages.

ANPC Workshops

Two workshops on rehabilitation and management of disturbed native vegetation

1. Ulladulla Civic Centre, NSW 25-26 October 2006
2. Coffs Harbour, NSW 14-15 March 2007

Are you involved in the rehabilitation of native vegetation? Does your work-site include native vegetation that you need to manage or rehabilitate? Do you participate in local rehabilitation projects? Are you interested in reversing the decline of native plant communities in your area? Then pick the workshop nearest to you!

Workshop focus

- The knowledge and skills required to undertake ecological rehabilitation and management of disturbed native vegetation.

Themes include:

- The ecological principles essential to planning a rehabilitation project;
- Understanding the task (the goal for the site, planning, resources, assessing site and vegetation condition, issues such as soil health and soil symbionts, provenance, riparian vegetation, impacts on waterways, monitoring and ongoing management, local issues); and
- Applying ecological principles to rehabilitation projects (case studies, site visits, demonstration and trialling of techniques).

The workshops will be a mix of presentations by experienced rehabilitation practitioners and visits to selected field sites. Participants will expand their skills and knowledge, challenge preconceptions, exchange ideas and expertise, work with experts and broaden networks.

Registration

For information on registration for either of these workshops, see the registration box.

These two workshops continue the workshop series conducted in regional NSW during 2005 and are supported by the NSW Government through its Environmental Trust.

ANPC Workshops (continued)

'From the Ground Up' Workshop on conservation and rehabilitation of grassy ecosystems of the ACT and region

28-29 November 2006 (note: date revised from previous notice)
CSIRO Discovery Theatre, Clunies Ross Street, Acton, ACT.

Workshop structure and content

This two-day workshop will cover topics such as: identifying grassy ecosystems (treeless grasslands, grassy woodlands), ecological principles underlying successful rehabilitation, the landscape context of a site, rehabilitation planning, assessment of site and vegetation condition, soil health and the role of soil-symbionts, management of threats, monitoring progress and ongoing management, learning from case studies.

We will visit two field sites differing in condition and management. Participants will break into smaller groups for demonstrations and trialling of techniques, discussion of management issues and rehabilitation approaches and some field-based plant identification.

Who should come?

Anybody interested in or responsible for the conservation, management or rehabilitation of grassy ecosystems in the ACT and local region. This includes community groups (coordinators and volunteers), extension and support officers, government agency staff, local government, environmental consultants, landholders and other land managers (e.g. the airport, power and water suppliers), other decision-makers and anyone interested.

Why 'from the ground up'?

The title reflects some important aspects of the workshop:

- thinking rehabilitation from the basics (an ecological approach);
- including soil health and soil-plant associations in rehabilitation planning;
- supporting grass-roots community workers and volunteers; and
- improving expertise of all working in on-ground conservation management.

Registration

For information on registration fees, see the registration box.

Project partner: Environment ACT.

Project supporters: Greening Australia (ACT & SE NSW), Friends of Grasslands (FOG), Ginninderra Catchment Group, Southern ACT Catchment Group, Molonglo Catchment Group, Monaro Grasslands Conservation Management Network.

This project is supported by an ACT Environment Grant.

Registration information for ANPC workshops

Registration forms for the three workshops above will be available on the ANPC website from early August http://www.anpc.asn.au/course1.html or from the ANPC Office.

The registration fee covers catering (morning & afternoon tea & lunch), field trips, the ANPC Plant Conservation Techniques manual on CD and includes GST. This fee covers costs not met by grants.

ANPC member:	$175	*Concession: $85
Non-member:	$195	*Concession: $105

* Concession for volunteer community group members, full-time students, pensioners.

Accreditation: Participation in ANPC workshops can contribute to qualifications in the Conservation and Land Management Training Package. Cost = $25 (incl. GST). More information available on request and on ANPC website: http://www.anpc.asn.au/course1.html#Courseaccreditation).

ANPC National Forum - April 2007 What lies beneath? The role of soil biota in the health and rehabilitation of native vegetation.

17-19 April 2007

CSIRO Discovery Theatre, Black Mountain, Acton, Canberra, ACT.

Forum Theme:

This national three-day forum will provide an opportunity for the sharing of the latest research outcomes on the role of soil organisms in ecosystem function and native vegetation rehabilitation. Practitioners will also demonstrate application to rehabilitation practice, share knowledge and skills gained from experience, and identify areas of research needed to fill knowledge gaps.

The forum theme is a response to a demand for scientific and practical guidance on this often overlooked but fundamental aspect of natural resource management

The forum will include:

- presentations on the role of soil biota in ecosystem function and native vegetation rehabilitation
- workshops, panels and discussions
- field visits demonstrating techniques and practical application.

Further information will be posted on the ANPC website as the forum evolves. http://www.anpc.asn.au/conferences.html

Notices will also be posted in this bulletin and on the ANPC email list.

Workshop on the Translocation of Threatened Plants – to be confirmed

20 April 2007 (immediately following the national forum)

CSIRO Discovery Theatre, Clunies Ross Street, Acton, ACT.

This workshop is essential for anyone involved in the planning, approval or implementation of translocation projects for threatened flora across Australia. The workshop is particularly relevant for environmental consultants and local government staff involved in the development approval process. The presenters include translocation experts who were involved in developing the *Guidelines for the Translocation of Threatened Plants in Australia* (ANPC, revised edition 2004) as well as selected case studies, highlighting lessons to be learnt.

Registration not open until workshop confirmed.

For further information on any of the above, contact:

ANPC National Office
Phone: 02 6250 9509 or email: anpc@anpc.asn.au

Conferences and Workshops

Parks and Protected Areas Management Congress (PPAMcon)

2-3 August 2006, Queanbeyan, NSW

The PPAMcon national congress will provide a forum where representatives from government, the private sector, community groups and environmental organisations can discuss, debate and analyse issues concerning the management of protected areas.

Further information: http://www.ppamcon.com.au/index.html or email: info@ppamcon.com.au, phone: David Rayfield (07) 3210 0021.

Evolution, Environment, Ecology & Botanic Gardens

15-17 September 2006, Cranbourne, Victoria

This is the Conference of the Association of Friends of Botanic Gardens. The Conference will focus on the evolution and ecology of our environment and the ongoing involvement of Friends of Botanic Gardens groups in these areas.

Further information: PO Box 151, Bulleen, Vic., 3105 or smartie@bigpond.com

15th Australian Weeds Conference

24-28 September 2006, Adelaide Convention Centre

The Conference theme is 'Managing Weeds in a Changing Climate'.

Further information: http://www.plevin.com.au/15AWC2006/

Acacia 2006: Knowing and Growing Australian Wattles

26-28 August 2006, Melbourne

Acacia 2006 brings together people interested in *Acacia*. The scientific section on the 'Science behind *Acacia*' will have sessions on the evolution and diversity of *Acacia*, utilisation of *Acacia* and the interactions of *Acacia* with other organisms. The horticultural section includes presentations on Wattles as weeds, and Wattles in landscaping. There is a field trip, and pre- and post-conference tours to see indigenous *Acacia* species.

Further information: http://www.rbg.vic.gov.au/acacia2006/

Plant Diversity in the Tropics

Australian Systematic Botany Society Conference

13-15 November 2006, James Cook University, Cairns

See: http://www.anbg.gov.au/asbs/conferences/

New Zealand Plant Conservation Network Conference

20-22 November 2006 (including field trip), Conference Centre, University of Auckland

This year's Network conference will be the Cheeseman Symposium 2006 – to celebrate the centenary of the publication of the first full flora treatment to be published by a resident New Zealand botanist, Thomas F. Cheeseman's *Manual of the New Zealand Flora* (1906).

See www.nzpcn.org.nz (under Conservation info > Events > Conference) for details and to download the registration form.

Conferences and Workshops (continued)

Seed Workshops in Victoria

October 2006 to February 2007

Introduction to seed collection is an informal introduction to all facets of seed collection. Sessions will be held at:

- Ballarat, Apollo Bay, Geelong, Inverleigh and at locations in the North Central Region of Victoria, Oct. to Dec. 2006. Contact: Anne Ovington, 5345 2200, anne.ovington@dpi.vic.gov.au
- South Gippsland, Dec. 2006. Contact Drew Liepa, 5662 5201, DrewL@wgcma.vic.gov.au
- Yarram region, Mullungdung Flora and Fauna Reserve, 20 Nov. 2006. Contact: Martin Potts, 5147 0954, mpotts.gav@dcsi.net.au

Seeds to Success is a five day accredited course designed for people with an interest in collecting seed from native vegetation, including data collection, extraction, cleaning, storage and propagation. Courses will be held at the Victorian Landcare Centre, Creswick, Nov-Dec 2006 and Jan-Feb 2007. Contact: Anne Ovington, 5345 2200, anne.ovington@dpi.vic.gov.au

Southern Connection Congress

22-26 January 2007, University of Adelaide, South Australia

Southern Connection is a group of scientists from all continents who study aspects of biology and earth history of the Southern Continents. Specific themes include ecology, biogeography, phylogeny, phylogeography, history and utilization. This conference has an arid-zone theme.

See: http://events.lincoln.ac.nz/southern/events.htm, or email Glenn Stewart stewartg@lincoln.ac.nz

3rd Global Botanic Gardens Congress

‘Building a Sustainable Future: the Role of Botanic Gardens’

16-20 April 2007, Wuhan, China

The Global Botanic Gardens Conference is held every three years. The 2007 Conference marks the 20th anniversary of Botanic Gardens Conservation International (BGCI) and will provide a global forum for the botanic garden community to share their knowledge, experience, practice and research.

Further information: http://www.3gbgc.com

Conserv-vision, the next 50 years: an international conference on conservation of biodiversity and historic resources

4-7 July 2007, University of Waikato, Hamilton, New Zealand

This conference celebrates the first 20 years of New Zealand’s Department of Conservation.

See: http://www.waikato.ac.nz/wfass/Conserv-Vision/

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Germplasm Conservation Guidelines for Australia:

An introduction to the principles and practices for seed and germplasm banking of Australian species.

ANPC, 1997

These guidelines for germplasm storage for the conservation, recovery and management of threatened flora were developed by the ANPC Germplasm Working Group.

They cover aspects of:

- germplasm collection
- seed storage
- vegetative propagule storage
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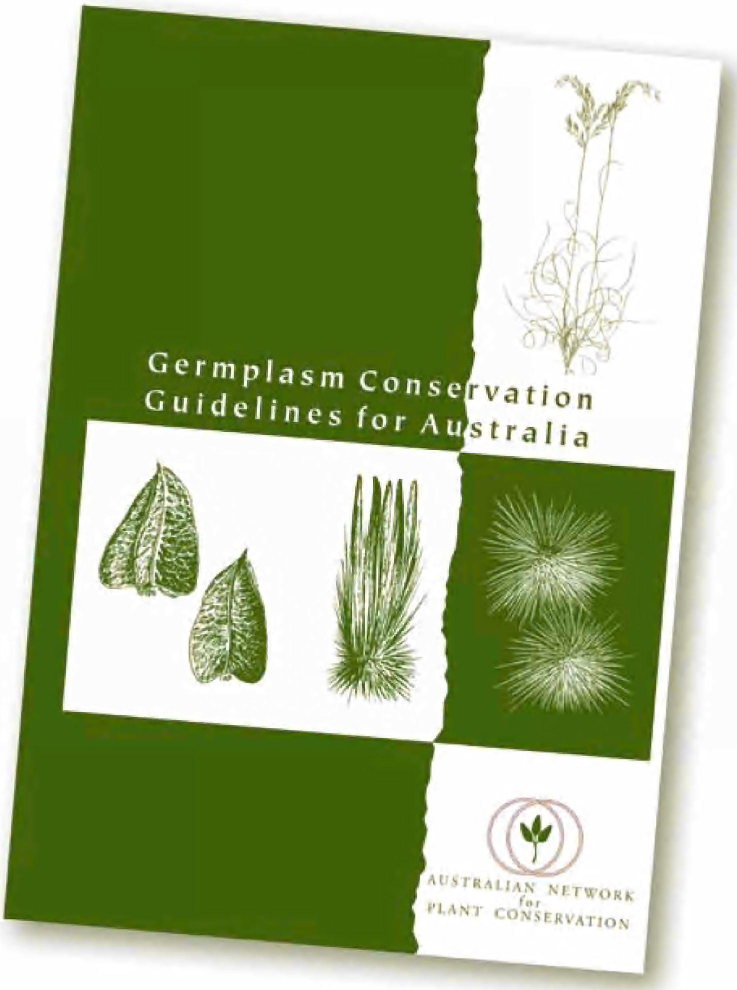
The guidelines give practitioners a 'How To' guide for *ex situ* germplasm conservation for threatened plant species.



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